CLAIMS

What is claimed is:

1. A method comprising compensating an actual inelastic gamma ray count rate detected by a pulsed-neutron logging tool for the effect of neutron transport by modifying the actual inelastic gamma ray count rate in an amount proportional to the effect of the neutron transport to create a compensated inelastic gamma ray count rate.

2. The method as defined in claim 1 further comprising calculating bulk density of a formation using the compensated inelastic gamma ray count rate.

3. The method as defined in claim 1 wherein compensating actual inelastic gamma ray count rate to create the compensated inelastic gamma ray count rate further comprises creating the compensated inelastic gamma ray count rate using an actual inelastic gamma ray count rate at a near detector, an actual inelastic gamma ray count rate at a far detector, and a correction coefficient.

4. The method as defined in claim 3 further comprising:

   modeling inelastic gamma ray count rates for a near detector of the pulsed-neutron logging tool;

   modeling inelastic gamma ray count rates for a far detector of the pulsed-neutron logging tool; and

   determining the correction coefficient from the modeling used to combine the near and far inelastic gamma ray count rates to create compensated modeled inelastic gamma ray count rates that are substantially free from neutron transport effects.

5. The method as defined in claim 3 wherein creating the compensated inelastic gamma ray count rate using an actual inelastic gamma ray count rate at a near detector, an actual inelastic gamma ray count rate at a far detector, and a correction coefficient further comprises using substantially the following equation:

$$CINEL = NINEL - X*FINEL$$

where CINEL is the compensated inelastic count rate, NINEL is the near inelastic count rate, FINEL is the far inelastic count rate, and X is the correction coefficient.

6. The method as defined in claim 1 wherein compensating the actual inelastic gamma ray count rate to create the compensated inelastic gamma ray count rate further comprises creating the compensated inelastic gamma ray count rate using an actual inelastic gamma ray count rate by a detector of the pulsed-neutron logging tool, an actual thermal capture gamma ray count rate by the detector, and a correction coefficient.

7. The method as defined in claim 6 further comprises:

modeling inelastic gamma ray count rates for the detector of the pulsed-neutron tool;

modeling thermal capture gamma ray count rates for the detector; and

determining the correction coefficient used to combine the inelastic gamma ray count rates and the thermal capture gamma ray count rates from the modeling that creates compensated modeled inelastic gamma ray count rates that are substantially free from neutron transport effects.

8. The method as defined in claim 6 wherein creating the compensated inelastic gamma ray count rate using the actual inelastic gamma ray count rate by the detector of the pulsed-neutron logging tool, the actual thermal capture gamma ray count rate by the detector, and the correction coefficient further comprises using substantially the following equation:

$$CINEL = INEL - Y*TC$$

where CINEL is the compensated inelastic count rate, INEL is the inelastic gamma ray count rate, TC is the thermal capture gamma ray count rate, and Y is the correction coefficient.

9. The method as defined in claim 1 wherein compensating the actual inelastic gamma ray count rate to create the compensated inelastic gamma ray count rate further comprises creating a compensated ratio count rate using ratios of an actual inelastic gamma ray count rate at near and far detectors of the pulsed-neutron logging tool, ratios of an actual thermal capture gamma ray count rate at the near and far detectors, and a correction coefficient.

10. The method as defined in claim 9 further comprising:

modeling ratios of inelastic gamma ray count rates for a near and far detector of the pulsed-neutron logging tool;

modeling ratios of thermal capture gamma ray count rates for the near and far detectors; and

determining the correction coefficient used to combine the ratio of the inelastic gamma ray count rates and the ratio of the thermal capture gamma ray count rates from the model to create compensated modeled ratio count rates that are substantially free of neutron transport effects..

11. The method as defined in claim 9 wherein creating a compensated ratio count rate using ratios of an actual inelastic gamma ray count rate at near and far detectors of the pulsed-neutron logging tool, ratios of an actual thermal capture gamma ray count rate at the near and far detectors, and a correction coefficient further comprises using substantially the following equation:

$$CRINEL = RIN - Z*RNF$$

where CRINEL is the compensated ratio of the inelastic count rate, RIN is the ratio of the near and far inelastic count rate, RNF is the ratio of the near and far thermal capture gamma ray count rate, and Z is the correction coefficient .

12. A logging system comprising:

a logging tool comprising:

a sonde operable within a bore hole;

a neutron source coupled to the sonde, the neutron source operable to produce high energy neutrons;

a near gamma ray detector coupled to the sonde at a first distance from the neutron source; and

a far gamma ray detector coupled to the sonde at a second distance from the neutron source, the second distance greater than the first distance;

a processor coupled to the neutron source and the near and far gamma ray detectors; and

wherein the processor calculates a compensated inelastic gamma ray count rate for a formation surrounding the logging tool, the compensated inelastic gamma ray count rate calculated by modifying actual inelastic gamma ray count rates in an amount proportional to the effect of neutron transport.

13. The logging system as defined in claim 12 wherein neutron source of the logging tool further comprises:

a neutron detector operable to determine a number of at least a portion of the produced; and

wherein the neutron source at least partially controls the number of neutrons produced during each activation of the neutron source.

14. The logging system as defined in claim 13 wherein the processor calculates a bulk density of the formation using the compensated inelastic count rate calculated as a function of count rates of the near and far gamma ray detectors per unit number of neutrons exiting the neutron source, and a correction coefficient.

15. The logging system as defined in claim 14 wherein the processor calculates the bulk density by applying the compensated inelastic count rate to a relationship between bulk density and compensated inelastic count rate determined from a modeled logging tool response.

16. The logging system as defined in claim 12 wherein the processor calculates a bulk density of the formation using the compensated inelastic gamma ray count rate being a compensated ratio of the inelastic count rate calculated as a function of the ratio of count rates of the near and far gamma ray detectors and a correction coefficient.

17. The logging system as defined in claim 16 wherein the processor calculates the bulk density of the formation by applying the compensated ratio of the inelastic count rate to a relationship between bulk density and compensated inelastic count rate determined from a modeled tool response.

18. A logging system comprising:

a logging tool comprising:

a sonde operable within a bore hole;

a neutron source coupled to the sonde, the neutron source operable to produce a substantially known quantity of high energy neutrons; and

a gamma ray detector disposed within the sonde at a spaced apart location from the neutron source.

19. The logging system as defined in claim 18 wherein the logging system is operable to calculate a bulk density of an earth formation.

20. The logging system as defined in claim 18 wherein the neutron source further comprises:

a neutron detector operable to determine a number of at least a portion of the neutrons produced; and

wherein the neutron source at least partially controls a number of neutrons produced.

21. The logging system as defined in claim 20 wherein the neutron source produces approximately 10^8 neutrons per second.

22. The logging system as defined in claim 18 further comprising:

a processor coupled to the logging tool;

wherein the processor is operable to compensate an inelastic gamma ray count rate for neutron transport effects to create a compensated inelastic gamma ray count rate.

23. The logging system as defined in claim 22 wherein the processor compensates the inelastic gamma ray count rate for neutron transport effects by computing the compensated inelastic gamma ray count rate using an inelastic gamma ray count rate of the gamma ray detector, a thermal capture gamma ray count rate of the gamma ray detector, and a coefficient.